their appropriateness has been demonstrated by the publication of these. But one cannot fail to honour the heroic perserverence which is borne witness to by experiments of this sort.

The paper by M. Dumas does not contain experimental results.

MARTIUS, *Ueber die Reactionszeit und Perceptionsdauer der Klänge*, Phil. Stud. 1890 VI 394.

MARTIUS, *Ueber den Einfluss der Intensität der Reize auf die Reactionszeit*, Phil. Stud. 1891 VII 469.

Dr. Martius here continues the publication of careful experiments on reaction-time carried out in his private laboratory at Bonn. In his first paper he gives experiments showing that the reaction-time becomes shorter as the pitch of a tone is taken higher. A monochord was used to produce the tones, and the times were measured with the Hipp chronoscope. C^{i}, c^{i}, c^{ii}, c^{iii} and c^{iv} were used, and the times compared with those obtained from the noise made by a hammer and anvil. In a general way the times are the same (in the neighborhood of 110σ) for c^{iv} as for the noise, and about 40σ larger for C^{i}. There are considerable differences with the three observers, which are probably due to the limited number of experiments, 12 to 19 of each sort, with an average variation of about 10σ. Martius concludes from a comparison of the reaction-times that 1 to 4 vibrations are sufficient to call up a sensation.

Prof. Stumpf in reviewing this paper (Zeitsch. f. Psych. II, 230-232) suggested that the difference in time of the reaction might be due to the greater intensity of the higher tone. Martius consequently made experiments in which the intensity was varied, and obtained as result that there is no difference in the length of the reaction-time for sounds of different intensities. This is contrary to the results obtained for several classes of stimuli by Wundt, Exner, v. Kries u. Auerbach, v. Vintschgau u. Honigschmied, v. Wittisch, Berger and the writer of this notice. Martius thinks that this discordance is explained by the greater attention given in his experiments, but it more likely due to the small range of intensity. The intensity of the sounds was not measured, but in no case can a monochord give a very loud sound.

REPSOLD. *Neuer Vorschlag zur Vermeidung des persönlichen Zeit-Fehlers bei Durchgangsbeobachtungen*, Astronomische Nachrichtungen 1889 Dec. 9, No. 2940.

BECKER, *Ueber einige Versuche von Durchgangsbeobachtungen nach dem neuen Repsold'schen Verfahren*, Astronomische Nachrichten 1891 May 19, No. 3036.

LANDERER, *Sur l'équation personelle*, Comptes rend. 1889 CVIII 21.

GONNESIAT, *Sur l'équation personelle dans les observations de passages*, Comptes rend. 1891 CXII 207.

STROOBANT, *Recherches expérimentales sur l'équation personelle dans les observations de passage*, Comptes rend. 1891 CXIII 457.

ANDRÉ ET GONNESIAT, *Etude expérimentale de l'équation décimale dans les observations de passage, faite à l'Observatoire de Lyon*, Comptes rend. 1892 CXIV 157.

CHRISTIE, *Change of personal equation with stellar magnitudes in transits*, Monthly Notices of the Royal Astron. Soc. 1891 455.

BACKHUYZEN, *Bestimmungen der persönlichen Gleichung bei Passagebeobachtungen*, Viertelj. d. Astron. Gesellsch. 1889 249.

A personal equation machine, The Sidereal Messenger 1891 139.

The photochronograph and its application to the star transits, Georgetown College Observatory 1891 36.

Prof. Wundt and Prof. Exner have called attention to the psychological interest of the personal equation long known to astronomers, and

Dr. Sanford has given in this JOURNAL a thorough historical and critical review of the subject up to 1888. Since then astronomers have continued the study of a subject so essential to their science. The accuracy with which time can be measured, and with which position and motion can be determined, is dependent on the personal equation, and reduction of the error by .01 sec. would be an important advance in astronomy. The papers by Dr. Repsold and by Prof. Becker suggest a new method for eliminating or lessening the personal equation. Repsold had previously proposed that the transit instrument might be moved at the same rate as the star, and the observer might at his leisure adjust the wire so as to bisect the star. If the position of the instrument were known, the time of transit could be measured very exactly. But the mechanical difficulties of moving and adjusting the instrument proved insurmountable, and Repsold now proposes that the wire only should be moved by the observer. This is done by means of a screw, and the position of the wire is registered automatically on the chronograph. A number of such registrations can be taken at short intervals during a single transit. Repsold tested his method artificially, and found the variable error of observation to be comparatively small (44σ to 27σ), and the constant error to be nearly eliminated. Becker tested the method in actual transit observations with less satisfactory results. The personal differences of four observers were obtained by the chronographic method and by Repsold's method, and the results were reduced in the usual manner. The probable error was found to be one-fourth to one-fifth larger by Repsold's method. It seems likely, however, that improvements in the apparatus and practice on the part of the observers would make this new method the most accurate hitherto used.

Of the reports in the *Comptes rendus* that by M. Stroobant has the most psychological interest. He calls attention to the fact, familiar to psychologists, but not systematically applied in astronomy, that an observer can judge when his registration is worse than usual. The writer of this notice finds in recent experiments that the error in adjusting a movement is about half as great as the error in perceiving it. The error in adjustment is perceived as an error and may be eliminated, the total error being thus reduced by about one-eighth. Stroobant finds that the "eye and ear" method is not much less accurate than the chronographic method. The first limb of a planet (artificial) was registered too soon (115σ to 238σ), and the second limb too late (16σ to 52σ). Registrations become later as a sitting is continued. Stroobant finds that he has a considerable decimal equation, and this error is more elaborately studied by MM. André and Gonnessiat. They find it to be about .05 sec. The decimal equation (first noticed by Prof. B. Pierce), is due to giving preference to certain decimals in estimating parts of seconds or millimetres. It would seem to be an error difficult to eliminate. Observers differ greatly, and an observer's knowledge of his own error would probably lead to its alteration. M. Landerer discusses the part which diplopia (doubling of the image) may play in transit observations. This defect can of course be corrected by glasses, but it may be increased by fatigue during the observation. The British astronomer royal gives the alteration in the personal equation with a change in the brightness of the artificial star. The star was darkened by gauze netting, but the alteration in intensity was not measured. The registration tended to become later, as the star was made less bright.

Prof. Backhuyzen explains his method for studying artificial transits, which is described in detail in Vol. VII of the annals of the Leiden Observatory. In this method the artificial star is stationary, and the apparent motion is obtained by a revolving prism. The Eastman personal equation apparatus is described anew in the *Sidereal Messenger*. This is the only artificial transit apparatus which the writer has examined

and he does not know how it compares with others. But it is one of the most recent and considered one of the best. The technical advances in psychology are borne witness to by the fact that the psychologist would not like to use a recording apparatus whose error is over 1σ, whereas the variable error of this instrument is about 20σ, and the constant error is not entirely eliminated by the ingenious method of reversing the motion of the carriage.

The paper last on this list is the most important for astronomy, but does not especially concern psychology. As long ago as 1849, Faye suggested the possibility of recording transits by photography, and this has now been actually accomplished. It is not necessary to describe here the methods and apparatus used in the Georgetown College Observatory under the general direction of the Rev. Father Hagen. Stars of the fourth magnitude have been successfully photographed in transit, what Prof. Young calls the "annoying human element" being largely eliminated. The photographic method will probably be applied with great advantage to many physical measurements.

The interests of psychology are not especially served by any of these papers. Astronomers naturally wish to do away with the personal equation rather than to study it. The most important advances have been in this direction. The Repsold method transfers the error to a certain extent from the observer to the instrument, and the photographic method does away with the observer altogether during the actual transit. The work of astronomers becomes less important for psychology as their devices become more mechanical, and as psychology itself learns to state and to solve its own problems. On the other hand recent advances in psychology are of increasing importance to astronomy and the other physical sciences. Physical measurements in the last resort must always depend on the accuracy of the eye and hand. Errors of observation are now studied in psychology with an exactness which has never been approached in any physical science. There are but few physicists and mathematicans who understand the position of psychology in this matter. The physicist cannot know the true value of the quantity he is seeking to determine; he deals with residuals not with errors. The psychologist on the other hand determines actual errors, and can study their nature, size and dispersion in a manner entirely beyond the reach of physics. The whole theory of the method of least squares is concerned with variable errors, and is helpless in the presence of constant or systematic errors. Constant errors are, however, far more important and dangerous than variable errors, and these can be measured and eliminated by the psychologist. Astronomers have, indeed, attempted this with their artificial transit instruments, but they have been playing the part of the psychologist, in most cases without adequate methods or knowledge.

ARDIGÒ, *Alcune osservazioni relative alla legge psicologica del riconoscimento*, Rivista di filosofia scientifica 1891 X 577.

The author relates an experience in the reproduction of a dream which seems to support his theory of re-cognition. He presents several considerations on cognate points from which he deduces two consequences, the one in regard to the association of ideas and the other relation to the theory of reasoning. The former denies that the process of association is the revival of terms one after the other that exist separately in the organic predisposition of the cerebrum, but asserts that it is a re-enlivement little by little in various parts of an ample system which acting in its integrity from one point to the other does so in successive moments and with variations of intensity in different parts. Thus it is